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THE VARIATIONS OF GLACIERS. XIII[1]

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The following is a summary of the *Twelfth Annual Report* of the International Committee on Glaciers.[2]

REPORT ON GLACIERS FOR 1906

Swiss Alps.—Of the sixty-three glaciers observed in 1906, fifty-three were retreating and ten were doubtful. Of the doubtful glaciers nine seemed to show a slight advance but it was not sufficient to establish a true change of phase.[3]

Eastern Alps.—Only thirty glaciers were measured in 1906; they were in the Ubergossene Alm, the Silvretta, Oetztal, Stubai, Zillertal, Venediger, Glockner, Ankogel, and Ortler groups and in southern Tyrol. Twenty-six glaciers were retreating, three were stationary, and one was advancing. The general retreat was stronger than in 1905. Of the five glaciers reported as advancing and three as stationary in the Oetztal in 1905, five are now retreating. The Grosselendkees in the Ankogel, which was stationary in 1905, shows a marked advance. It is the only advancing glacier amongst those observed.[4]

Italian Alps.—All the glaciers that were observed in 1906 in Val Tournache, in Val Formazza, and in the Lombard Alps were retreating. The Forno glacier in Valfurva retreated rapidly between 1864 and 1895, and a little later became stationary. Its névé-fields seem to have diminished in the last ten years, suggesting a coming retreat.[5]

French Alps.—An examination of earlier observations has brought to light the changes which took place in the Glacier des Bossons between 1818 and 1904. At the later date the glacier was 600 meters shorter than in 1818. It seems to be advancing slightly at the present, although the other glaciers of the region, and those in the nearby regions of Maurienne and Tarantaise are retreating. Large-scale maps of the ends of several glaciers have been made for future comparisons. Several small glaciers have entirely disappeared. A number of glaciers measured in the Dauphiné are retreating rapidly and some small ones have disappeared.

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[1] The earlier reports appeared in the *Journal of Geology*, Vols. III–XVI.

[2] *Zeitschrift für Gletscherkunde*, 1908, Vol. II, pp. 161–98.

[3] *Report* of Professor F. A. Forel and M. E. Muret.

[4] *Report* of Professor E. Brückner.

[5] *Report* of Professor O. Marinelli.

Pyrenees.—The glaciers are retreating but the precipitation was heavy during the previous winter, and two glaciers are getting thicker in their upper portions.[1]

Norway.—The four glaciers measured in the Folgefon and in the Jostedal have advanced from 15 to 33 meters since 1905. In the Jotunheim seven glaciers have advanced and nine have retreated during the year. The greatest advance was 12.8 meters and the greatest retreat 22.5 meters.[2]

Russia.—Two glaciers on the northern slope of the mountain chain of Peter the Great, Boukhara, are rapidly melting back, whereas a glacier on the southern slope of the same chain is, according to observations in 1905, notably advancing. A number of glaciers are reported in the Tian Chan mountains and, although not measured, several seem to be advancing.[3]

Canada.—The report contains an interesting summary of the observations of the Messrs. Vaux on the Illecillewaet, Asulkan, Wenkchemna, Victoria, Wapta, and Horseshoe Glaciers, since 1898. It will be unnecessary to repeat the details here as the article has been published in extenso in this country.[4] Suffice to say that these glaciers have in general retreated, but at a diminishing rate; the Asulkan has advanced slightly, but has retreated again to its position of 1899; the Illecillewaet continues to retreat, but photographs show that the upper part is getting thicker, and it will be interesting to determine how soon this will affect the end.[5]

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[1] *Report* of M. Ch. Rabot.

[2] *Report* of M. P. A. Oyen.

[3] *Report* of Colonel J. de Schokalsky.

[4] "Observations made in 1906 on Glaciers in Alberta and British Columbia," *Proc. Philad. Acad. Nat. Sci.*, 1906, pp. 568–79.

[5] *Report* of MM. George and William S. Vaux.

Himalayan Glaciers.—Steps have been taken by the Geological Survey of India to survey and mark the positions of the ends of several glaciers; photographs will be taken and observations made at future times, which will determine the changes they undergo.[1]

REPORT ON THE GLACIERS OF THE UNITED STATES FOR 1907[2]

The snow fall in the Rocky Mountains was so great during the previous winter that the Hallet glacier in Colorado was not uncovered during the summer of 1907, and therefore it is probable that it has made a small advance (*Mills*). Three small glaciers are reported in the Crazy Mountains of Montana, one each in Big Timber, in Sweet Grass and Rock Creek canyons, respectively (*Wolfe* and *Mansfield*). There is no report on the Californian glaciers, but the snow-fall in the Sierra Nevadas was unusually great during the preceding two winters (*Le Conte*).

The snow fall seems also to have been excessive in the Cascade Mountains of Oregon, though the annual precipitation at Portland, Oregon, was but normal (*Montgomery*). The Eliot Glacier, on the northern side of Mt. Hood, continues to retreat. A comparison of a photograph taken in 1907, with earlier ones, shows a marked recession, and the slope at the end of the glacier is much diminished, (*Langille*). Mr. A. H. Sylvester[3] has made a topographic map of Mt. Hood and the region west of it which is to be published by the United States Geological Survey. He observed glacial scratches and old moraines at a considerable distance from the mountain. He reports evidences of a small advance in most of the glaciers which is referable to the heavy precipitation during recent years, but he thinks the Zig Zag and White River glaciers are retreating on account of the greater activity of the fumarole at their heads, which has melted a large quantity of snow in the old crater of the mountain. In the canyon below White River Glacier he has found ice buried in places by more than 200 feet of débris, which he takes to be all morainic. This ice occurs under what has been called the Moraine Mesa, as its surface is covered by a well marked ground moraine. Mr. Sylvester looks upon the material below this moraine as an earlier moraine; between the two is a confused mass of forest humus and broken trees, some of which seems still to be in place; and he infers two periods of glaciation separated by a long interval with a mild climate. The present writer, who visited the mountain in 1901,[1] looks upon the lower material as ejecta. The presence of ice under it would then indicate that an older glacier was buried under the material thrown out during a period of great activity; and the steam which would continue to escape, in gradually diminishing quantities, would prevent the formation of glaciers for a long time; even after the snow again began to accumulate, it would require a century or more before the White River Glacier would extend to the region of the Moraine Mesa; and no great variations of the climate would be necessary to account for the buried forest. It is not improbable that the great outburst was the cause of the disappearance of the southern wall of Mt. Hood's crater.

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[1] *Report* of M. Douglas W. Freshfield.

[2] A synopsis of this report will appear in the *Thirteenth Annual Report* of the International Committee. The report on the glaciers of the United States for the year 1906 was given in this *Journal*, Vol. XVI, pp. 51–55.

[3] "Is Our Noblest Volcano Awakening to New Life?" *Nat. Geog. Mag.*, July, 1908, Vol. XIX, pp. 515–25.

Mr. George Davidson made a trip in southeastern Alaska in 1907 and noticed a general retreat of the glaciers and diminution of the snow-fields since his earlier visits in 1867–69. The only definite information we have regarding Glacier Bay is contained in two short notes by members of the International Boundary Survey.[2] A small sketch map of Muir and Reid Inlets accompanies Mr. Morse's report. These notes show that between 1894 and 1907, Muir Glacier has retreated eight miles, Grand Pacific Glacier, seven and one-half miles, and Johns Hopkins Glaciers, three miles. Only a small part of the end of Muir Glacier is discharging ice-bergs.[3] That the rapid retreat common to all the glaciers of the bay was in some cases started, and in others helped, by the earthquake of September, 1899, has been the general belief on account of the great quantity of floating ice which the excursion steamers encountered the following summer, and which has ever since filled the bay, especially from Muir Inlet southward. This belief is confirmed by the experience of Mr. August Buschmann, who was in charge of the cannery at the mouth of the bay in 1899. He reports that immediately after the earthquake the quantity of drift ice in the bay increased and made navigation very difficult for his small steamers.

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[1] "The Glaciers of Mt. Hood and Mt. Adams," *Mazama*, 1905, Vol. II, pp. 194–200; and "Studies of the Glaciers of Mt. Hood and Mt. Adams," *Zeitschrift für Gletscherkunde*, 1906, Vol. I, pp. 113–32.

[2] Otto J. Klotz, "Recession of Alaskan Glaciers," *Geog. Jour.*, 1907, Vol. XXX, pp. 419–21; Fremont Morse, "The Recession of the Glaciers of Glacier Bay, Alaska," *Nat. Geog. Mag.*, 1908, Vol. XIX, pp. 76–78.

[3] It is to be noted that Mr. Klotz interchanges the names of the Grand Pacific and the Johns Hopkins glaciers.

The glaciers descending from the Brabazon range of mountains, facing the coast between the Fairweather Range and Yakutat Bay, give evidence that they are retreating by the existence of moraines at some distance from the ice; the intervening region is barren, but trees in general grow on the outer side of the moraines. One glacier, the Yakutat, has its origin in the great snow fields behind the mountains and passes completely through the range; it is retreating like the others.[1]

The interpretation heretofore put upon the narratives of Malaspina and of Vancouver, regarding the ice in Disenchantment Bay, has been that the glaciers actually filled the bay as far as Haenke Island in 1792 and 1794. But Messrs. Tarr and Martin,[2] by a consideration of the general character of the vegetation, the absence of lacustrine deposits in the lower part of Russell Fiord, the strongly marked shore lines in Disenchantment Bay, and finally by a critical examination of the accounts of the two early explorers, have concluded that they merely encountered compact floating ice in the neighborhood of Haenke Island, and that the glaciers did not, at the time of their explorations, extend to this island.

In the Aleutian Islands, the volcano of Makushin, Unalaska, and the volcanic mountains of Atka, carry large névé-fields with radiating glaciers; they do not show any signs of retreat; it is probable that they are advancing, for the Aleutian Islands are unquestionably in process of elevation (*Jaggar*).

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[1] Eliot Blackwelder, "Glacial Features of the Alaskan Coast between Yakutat Bay and the Alsek River," *Journal of Geology*, 1907, Vol. XV, pp. 415–33.

[2] "Position of the Hubbard Glacier Front in 1792 and 1794," *Bull. Am. Geog. Soc.*, 1907, Vol. XXXIX, pp. 129–36.